compression impulses to desired zones in the workpiece;

K. Intrinsic energy interaction with materials, in contrast with indirect methods (e.g., heating materials from an external source) used in conventional hot forging and forming;

L. Safety and nondestructive inspection factors in this second embodiment are similar to those realized in the first embodiment;

A variant of the second embodiment of this invention is application of coincident or superposed shear and compression mode impulses to non-metallic materials to:

M. Effect cohesion among contiguous elements or laminae; and

N. Activate adhesive agents within or on surfaces of contiguous elements or laminae.

While the invention has been described in connection with a preferred embodiment, it is not intended to limit the scope of the invention to the particular form set forth, but on the contrary, it is intended to cover such alternatives, modifications, and equivalents as may be included within the spirit and scope of the invention as defined by the appended claims.

Claims

What is claimed is:

An apparatus and method for sonic welding and materials forming comprising:

1. A sonic lens which receives an energetic compression wave impulse whereby;

(a) said sonic lens directs and transmits said energetic compression wave impulse at a defined angle of incidence on a workpiece;

(b) said incident compression impulse refracts and and mode converts into a high-power-density sonic shear wave impulse into a workpiece;

(c) said workpiece material in the path of said sonic shear wave impulse is transformed from a solid state to a viscoelastic state;

(d) further, said sonic lens also partitions, directs and transmits said energetic compression wave impulse at a normal or right angle of incidence on said workpiece;

(e) direction of said incident compression impulse is transmitted into said workpiece as a high-power-density sonic compression wave impulse which superposes in time and space with said sonic shear wave.

compression wave impulse coincident in time and space within a workpiece;

(f) said sonic shear wave impulse transforms materials from a solid state to a viscoelastic state;

(g) said sonic compression wave impulse superposes a transient positive stress on said materials transformed to said viscoelastic state;

(h) said sonic compression wave impulse, induced by said sonic lens, induces a high-energy-density compression transient impulse, superposed on said viscoelastic material state in said workpiece;

(i) said sonic lens is positioned in one or multiple configurations adapted to application requirements;

(j) said apparatus functions with a range of energy sources, including but not limited to: single or multiple explosive charges, single or multiple mechanical impacts, single or multiple pneumatic impulses, and single or multiple electrodynamically driven impulses;

(k) said sonic shear wave energy is derived and partitioned from said sonic

compression wave impulse, directed by a refraction angle codependent with inherent sonic wave velocities of said sonic lens and said workpiece;

(l) said sonic lens composition, size, shape and array configuration in multiple lens applications, provides for spatial and temporal superposition of said sonic compression wave impulse and said sonic shear wave impulse;.

(m) said sonic lens composition and shape are covariable;

(n) said energy sources may be modulated to afford a desired range of power spectral densities; and

(o) sonic waveguides may be applied for impedance matching among said energy sources, said sonic lenses, and said workpiece.

2. A process for an apparatus and method for sonic welding comprising the steps of:

(a) Creating a high energy sonic compression impulse impinging on a sonic lens. Inducing a sonic shear wave impulse through sonic wave mode conversion by said sonic lens;

(b) Focusing and directing said sonic shear wave impulse to attain high-power-density at selected zones in said workpiece by said sonic lens. Superposing said high-power density shear wave impulse on said workpiece selected element interfaces to transform materials from solid state to viscoelastic state;

(c) Welding at contiguous element interfaces in said workpiece which have been transformed from said solid state to said viscoelastic state, through

superposition of said sonic shear wave impulse and said sonic compression wave impulse, in any combination thereof, to displace adhesion and cohesion inhibiting substances; and

(d) Further, said process and apparatus may be applied to activate cohesion and adhesion enhancing substances, within or affixed to, said workpiece to weld, fuse, or bond elements among selected interfaces within said workpiece.

3. An apparatus and method for sonic forming of materials comprising:

(a) Superposition of a sonic shear wave impulse and a sonic compression wave impulse superposing in time and space within a workpiece;

(b) Said sonic shear wave impulse transforms materials from a solid state to a viscoelastic state;

(c) Said sonic shear wave impulse is induced by a sonic lens which creates a high-power-density within the body of a workpiece;

(d) Said sonic compression wave impulse applies a transient positive stress on said materials transformed to said viscoelastic state;

(c) Said sonic compression wave impulse is directed by said sonic lens which creates a high-power density compression transient within the body of said workpiece;

(d) Said sonic lens is positioned in one or multiple configurations adapted to application requirements;

(e) Said apparatus functions with a range of energy sources, including but not limited to: single or multiple explosive charges, single or multiple mechanical

impacts, single or multiple pneumatic impulses, and single or multiple electrodynamically driven impulses;

(f) Said sonic shear wave impulse is derived and partitioned from said sonic compression wave impulse through refraction angles codependent with inherent sonic wave velocities of said sonic lens and said workpiece;

(g) Said sonic lens spatial distributions and configurations provide for superposition of said sonic compression wave impulse and said sonic shear wave impulse through adjustment of impulse transit time for each said sonic impulse originating from said energy sources;

(h) Said sonic lens composition and shape are covariable;

(i) Said energy sources may be modulated to afford a desired range of power spectral densities; and

(j) Sonic waveguides may be applied for impedance matching among said energy sources, said sonic lens, and said workpiece.

4. Said sonic lens apparatus of claim 1 provides for a method of materials substructure modification whereby:

(a) Said superposition of sonic compression wave impulse on material transformed from said solid state to a viscoelastic state by said sonic shear wave impulse, displaces viscoelastic materials within the body said workpiece;

(b) said materials displaced within the body of said workpiece selectively deform in response to an imposed quasistatic load;

(c) said workpiece substructure is modified by said quasistatic load, and the

spatial and temporal imposition of said sonic shear wave and said sonic compression wave impulses; and

(d) said substructure modification includes, but is not limited to, metallic grain boundary ordering, residual stress relief, phase transformation, and annealing.

5. Said sonic lens apparatus of claim 1 provides for a method of materials joining whereby:

(a) Said superposition of sonic compression wave impulse on material transformed from said solid state to a viscoelastic state by said sonic shear wave impulse, activates adhesive fusion of contiguous dissimilar materials at interfaces within the body of said workpiece;

(b) said superposition of sonic compression wave impulse on material transformed from said solid state to a viscoelastic state by said sonic shear wave impulse, activates adhesive fusion of contiguous dissimilar materials at interfaces between contiguous surface elements of said workpiece; and

(c) said superposition of sonic compression wave impulse on material transformed from said solid state to a viscoelastic state by said sonic shear wave impulse, activates cohesive fusion of contiguous similar materials at interfaces within the body or on the surface of elements of said workpiece.